

Future Gamma-ray Missions for Multi-Messenger Astrophysics: BurstCube, AMEGO-X, and AMEGO

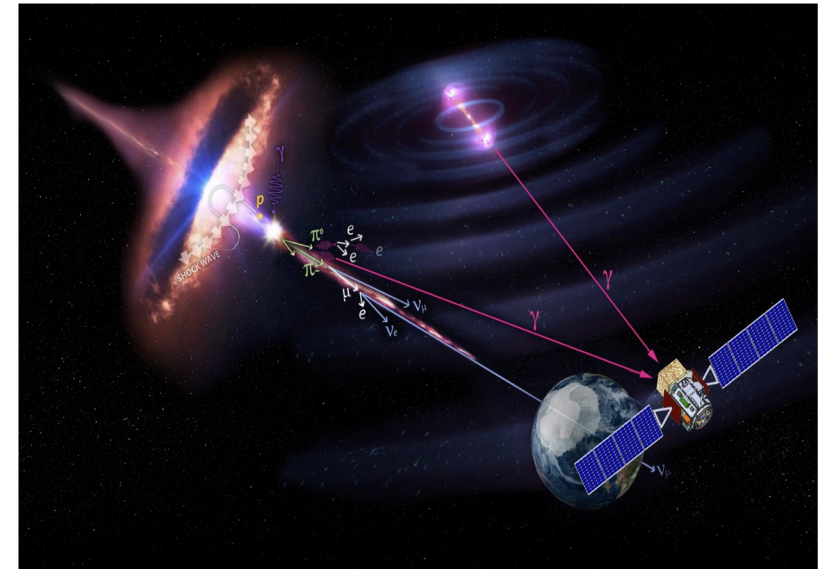
Judy Racusin (NASA GSFC)

On behalf of the BurstCube, AMEGO-X, and AMEGO Collaborations



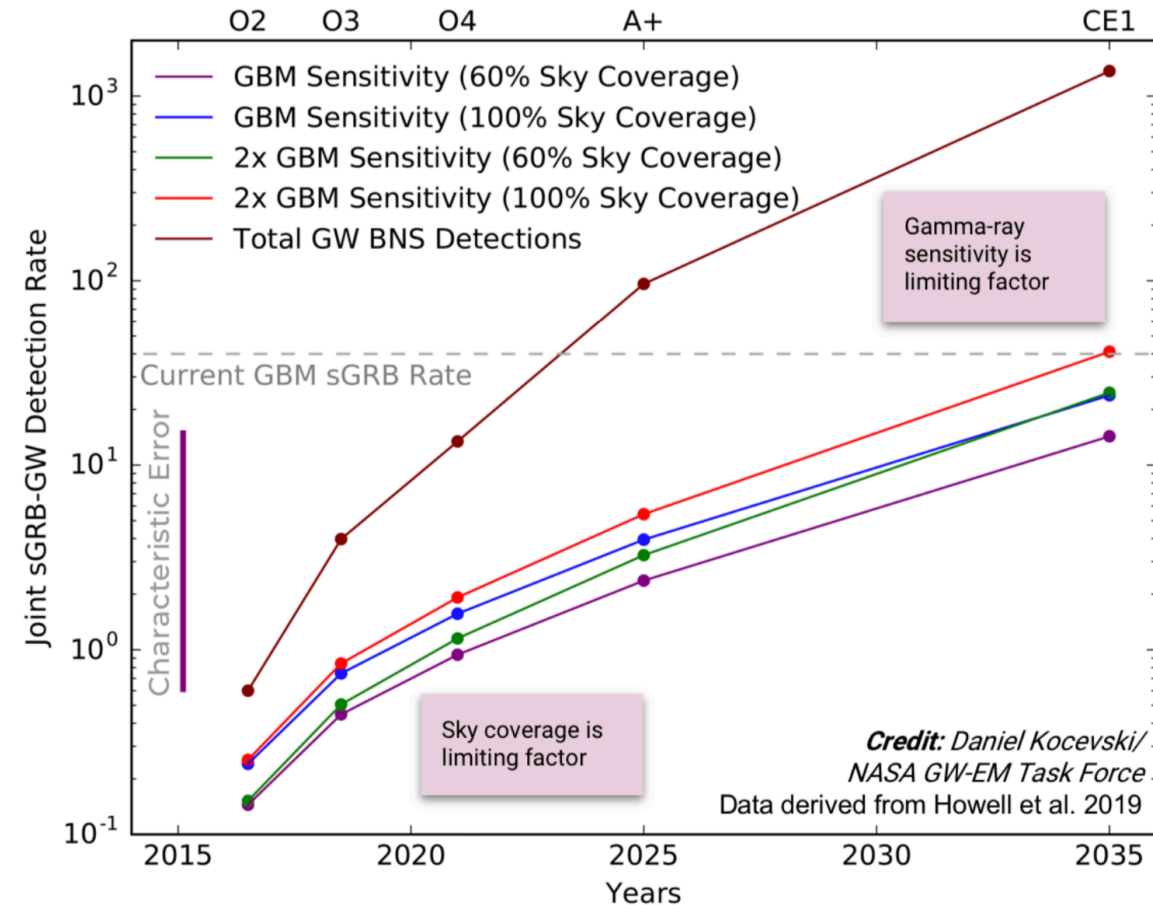
Gamma-ray + MMA Science

- Gravitational Waves from Neutron Star Mergers + Gamma-ray Bursts
 - Explosion Energetics and Emission Mechanisms
 - Speed of Gravity, Lorentz Invariance and other fundamental physics constraints
 - Clues to Progenitor System Properties
 - Nuclear processes in nearby kilonovae
- Neutrinos + Gamma-rays
 - AGN Flares – particle acceleration, emission mechanisms, jet composition
 - Nearby Supernovae – element formation



Gamma-ray Observational Priorities for MMA

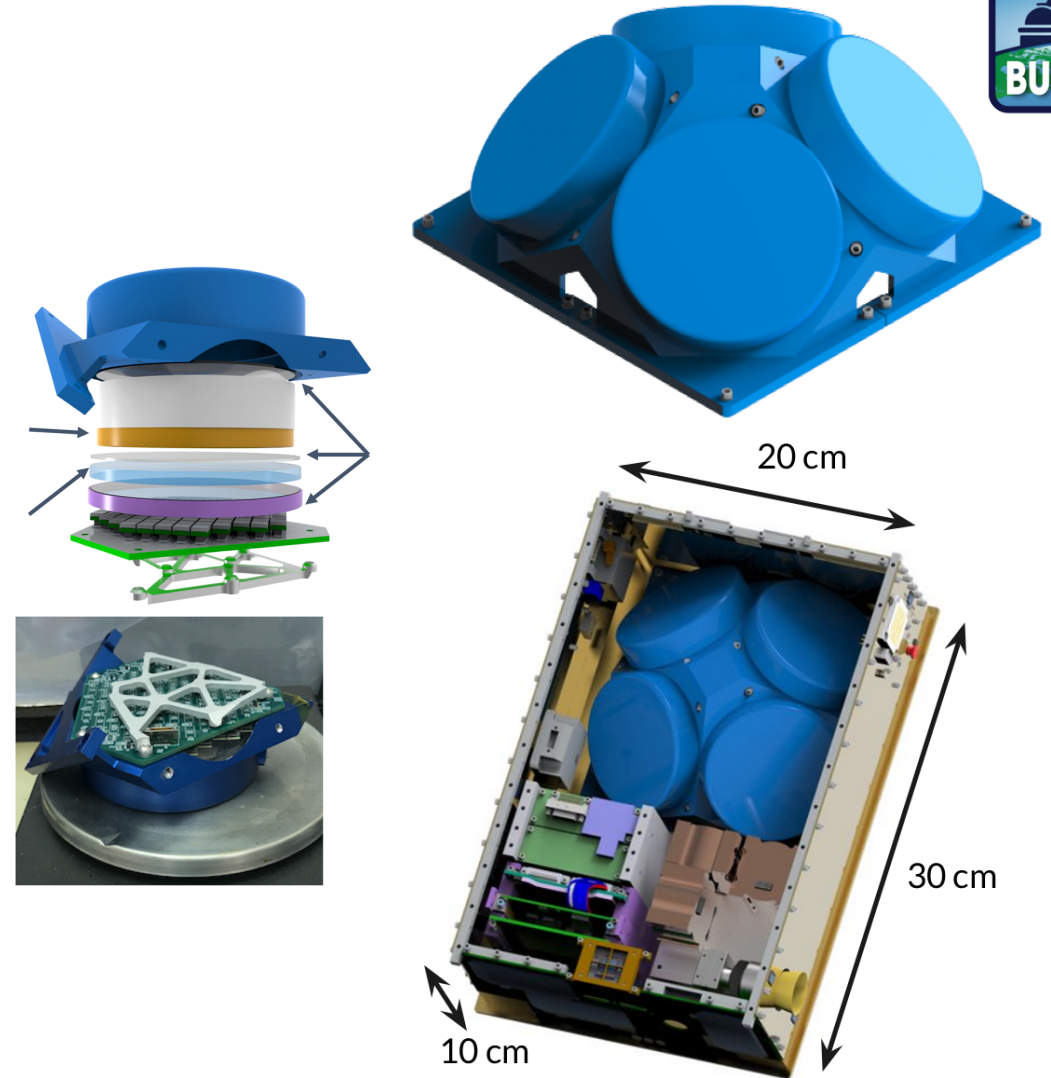
- Needed to detect MMA Counterparts
 - All-sky Exposure (instantaneous or close to it)
 - Broadband Sensitivity
 - Small Localizations/spatial resolution
- Bonus Capabilities
 - Energy resolution
 - Polarization
- Many technologies and platforms can realize this phase space, and GW & Neutrino upgrades guide EM capabilities
- Examples:
 - BurstCube – 6U CubeSat
 - AMEGO-X – MidEX Concept (for 2021 A0)
 - AMEGO – Probe Concept



BurstCube: A CubeSat for Gravitational Waves Counterparts



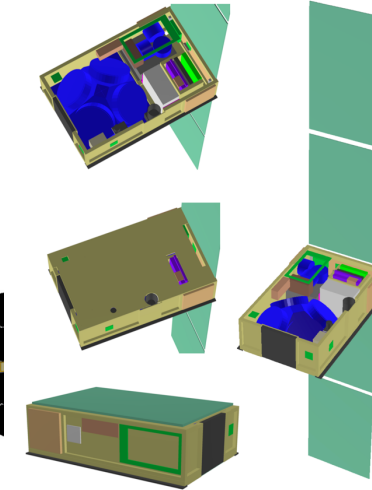
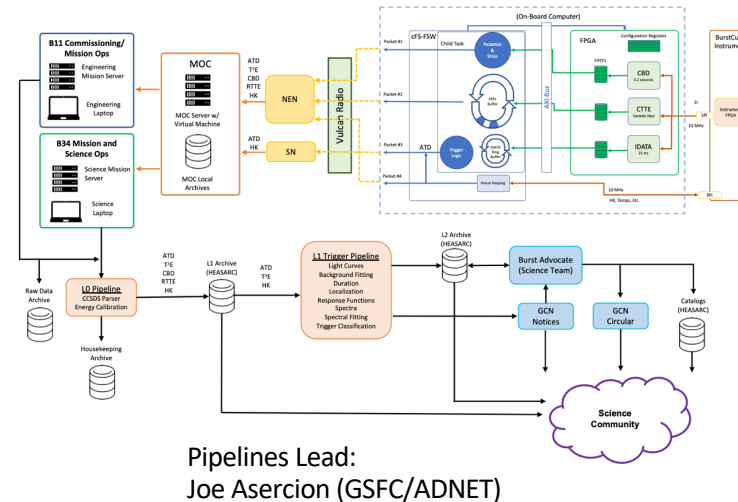
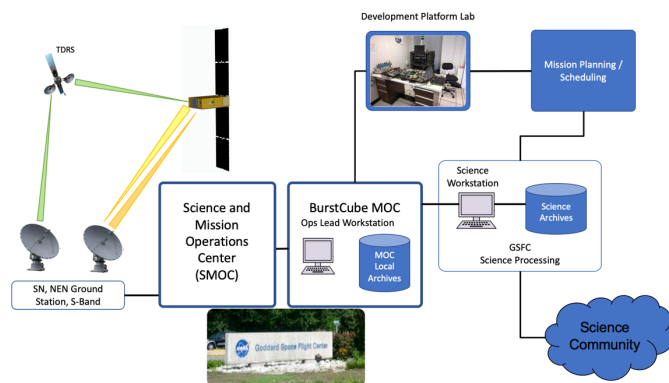
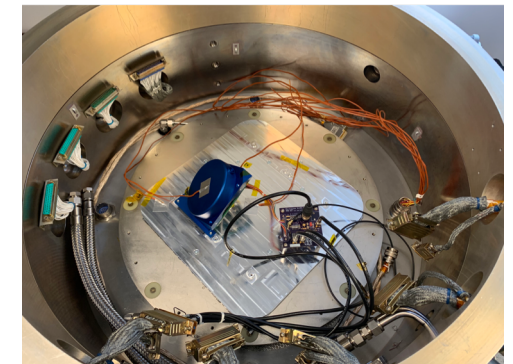
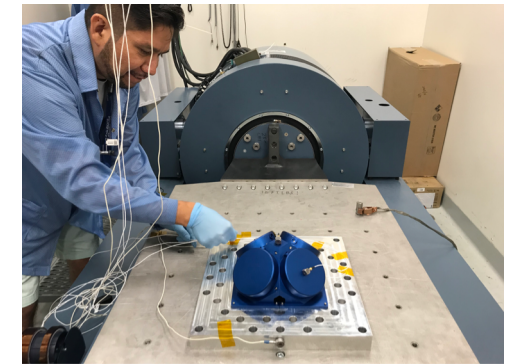
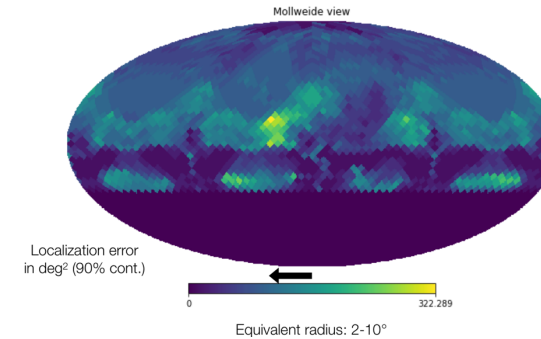
- 6U CubeSat with the primary goal to detect, localize, and characterize short Gamma-ray Bursts (SGRBs)
- Complementary to existing gamma-ray transient detectors – adding sky coverage
- Instrument:
 - Four CsI(Tl) scintillators coupled to arrays of silicon photomultipliers (SiPMs)
 - Energy range: ~ 50 keV – 1 MeV
 - Field of View: 50% of the sky
- Rapid communications via TDRS
- Deliver BurstCube to launcher Jan 2022



PI: Jeremy Perkins (GSFC)

BurstCube Status

- Designs completed in mid-2020
- Instrument and Spacecraft under construction
- Developing Ground System infrastructure, hardware, calibrations, software, pipeline
- Instrument and science simulations
- Team includes undergrads, grad students, and postdocs with key roles



Science Software and Simulations lead:
Israel Martinez (GSFC/UMD/CRESST)

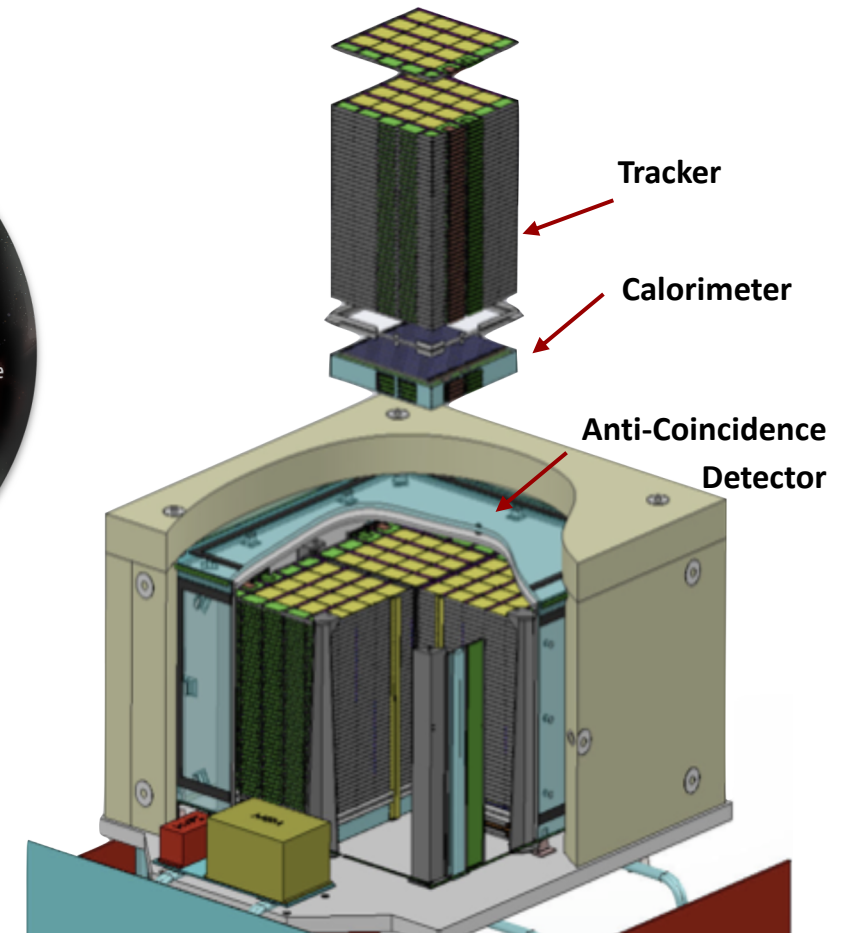
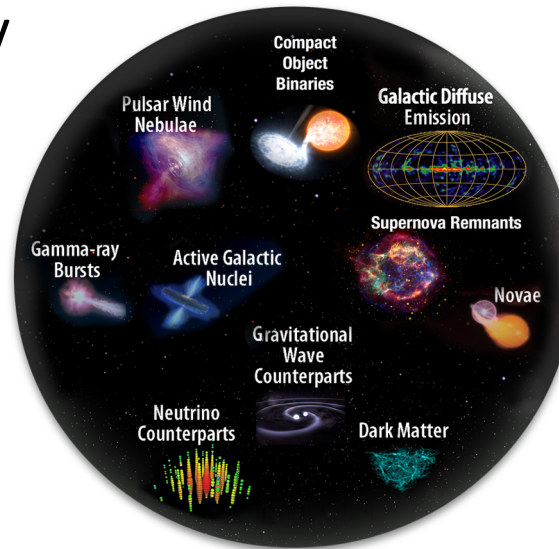
BurstCube Protoflight Detector Environmental Testing

Instrument Managers: Jacob Smith (UMBC/CRESST), Georgia DeNolfo (GSFC)

All-sky Medium Energy Gamma-ray Observatory eXplorer (AMEGO-X)

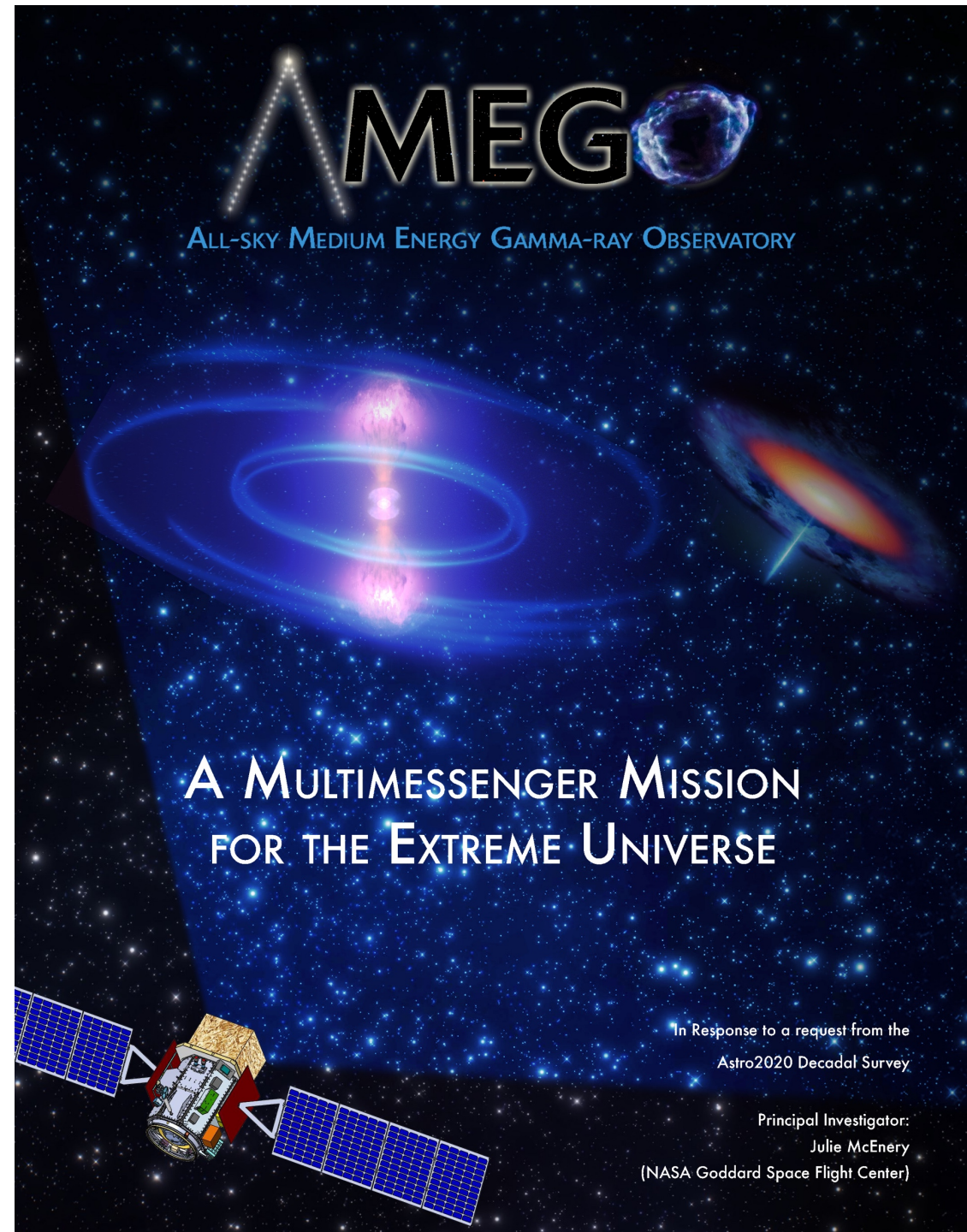
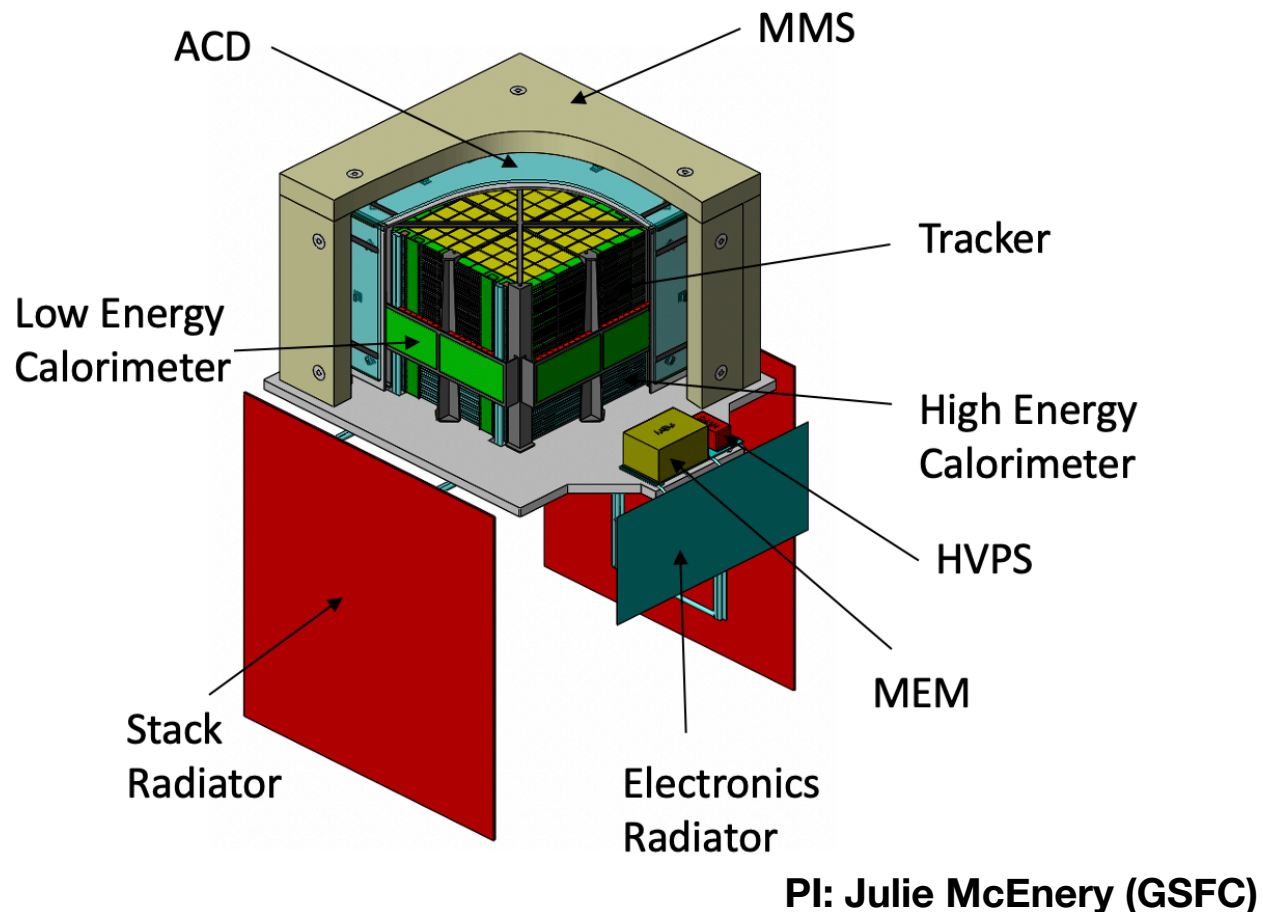


- Compton + Pair telescope that will open a new window into the MeV sky
- Broad energy band: 300 keV – 1 GeV
- All-sky survey with 2.5 sr FoV
- Instrument:
 - Potential new silicon pixel tracker (see Isabella's talk next)
 - CsI Calorimeter
 - ACD
- Rapid detection and localization of transients
- Low inclination LEO orbit
- In development for 2021 MidEx AO

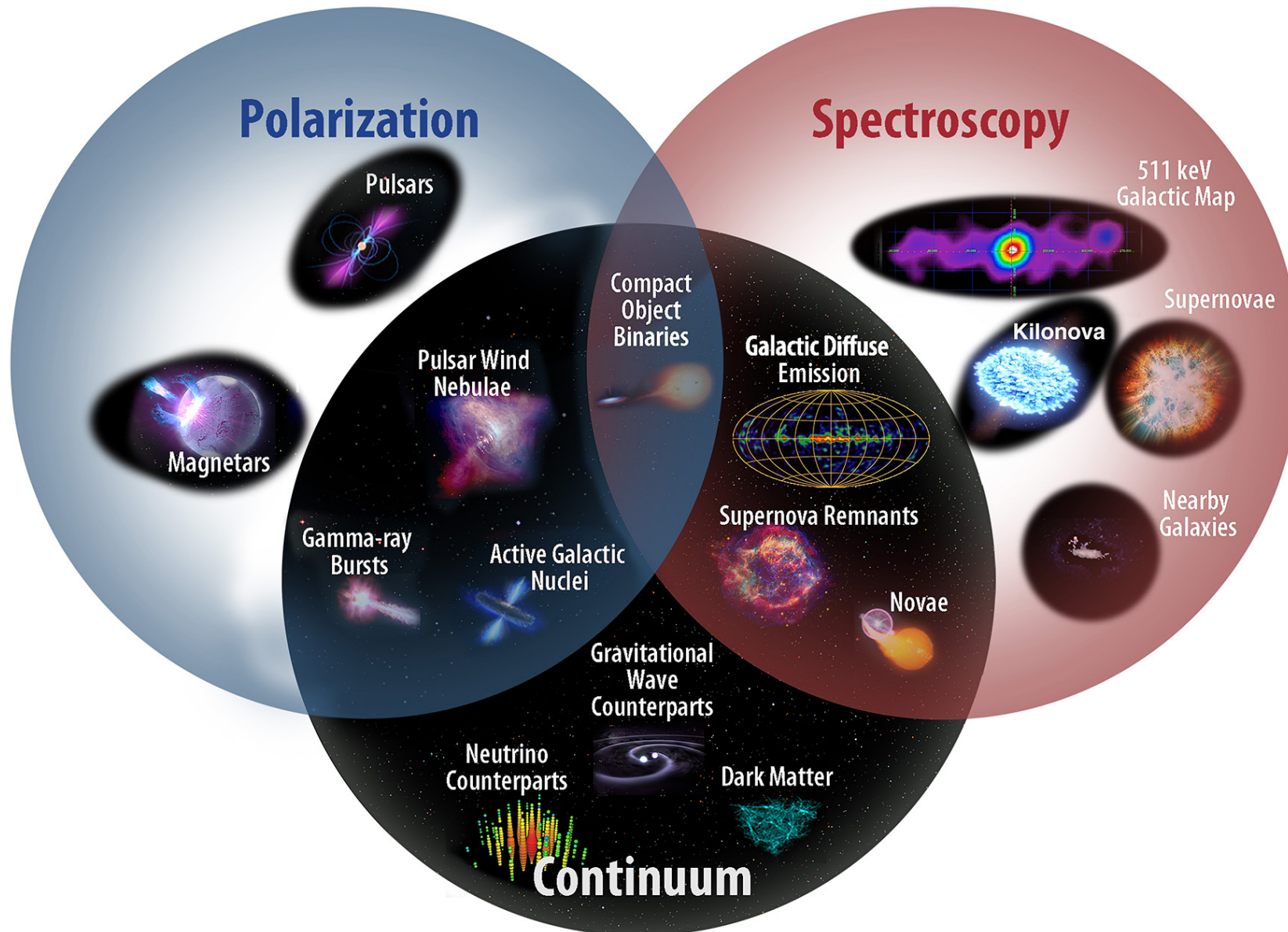


PI: Regina Caputo (GSFC)

All sky Medium Energy Gamma-ray Observatory (AMEGO)



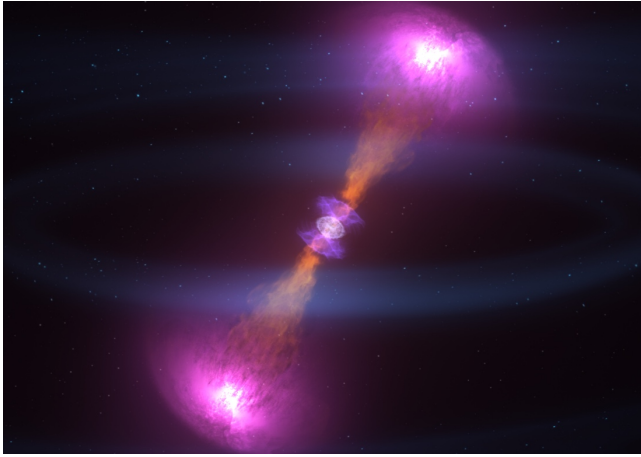
AMEGO opens huge discovery space!



AMEGO is a Multimessenger Observatory

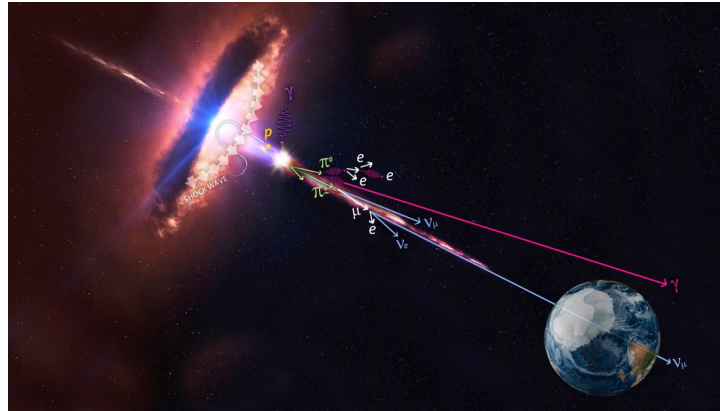


Extreme Explosions – GW counterparts



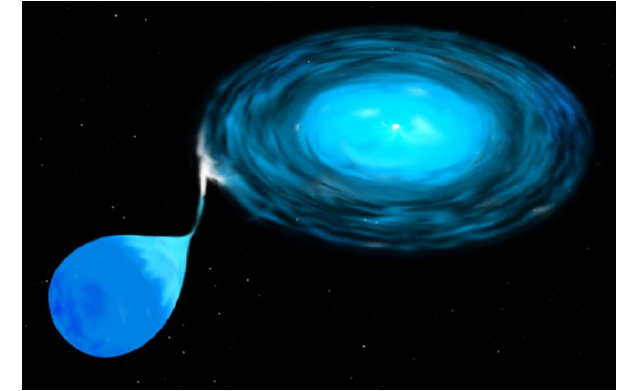
- High rate of well localized ($\sim < 1$ deg) GRB
 - ~ 100 short GRB/year
 - ~ 450 long GRB/year
- Polarization probe GRB jets
- Direct observation of gamma-rays from nuclear processes in nearby kilonova

Extreme Accelerators – VHE Neutrino counterparts



- Gamma-rays are generated in the same physical process that produces neutrinos
- Continuous monitoring of hundreds of the most luminous blazars
- MeV flux good proxy for neutrino flux
- Polarization observations probe jet composition

Element formation – MeV Neutrino counterparts



- Gamma-ray line flux as function of time provides good measure of geometry and total mass of Ni in SN1A
- AMEGO will detect SN1A out to 50 Mpc

For more information on AMEGO/AMEGO-X

- MeV Astronomy: Unlocking the multi-Messenger Universe (Splinter Session)
- C. Karwin talk 109.01, Detecting Cosmic Neutrino Counterparts with Next-Generation Gamma-Ray Telescopes
- H. Fleischhack iPoster 132.01, Simulating the instrument performance of the AMEGO mission
- C. Kierans talk 315.04, AMEGO: Exploring the Extreme Multimessenger Universe
- E. Orlando talk 439.01, Toward a Consistent Model of the Galactic Non-Thermal Interstellar Emission from MHz to TeV
- X. Wang talk 440.03, MeV Gamma Rays from Neutron Star Mergers: A Distinct Signature of r Process Fission
- A. Zoglauer iPoster 541.07, Enhancing the event reconstruction pipeline of future combined Compton-scattering and pair-creation telescopes with deep learning